CLAIMS

1. An optical pickup apparatus comprising:

(a) objective spot forming means (30) for forming each spot (M, E, F, G, H, I, and J) of a plurality of light beams entered via a collimator (28), on each track of a recording medium (34);

(b) a plurality of photodetectors (52M, 52E, 52E, 52F, 52G, 52H, 52I, and 52J) each provided for each spot (M to J) for receiving reflected light of each spot (M to J), the reflected light having passed through said objective spot forming means (30), said collimator (28), and focus adjusting means (50) in this order; and

(c) a chassis (70) mounted with said collimator (28),

wherein said focus adjusting means (50) and said plurality of photodetectors (52M to 52J) are supported respectively by a focus adjusting means support member (72) and a photodetector support member (70) formed separately from said chassis (70), and the focus adjusting means support member (72) and the photodetector support member (78) are fixed to said chassis at positions along an optical axis, the positions being visually confirmed that the reflected light of each spot (M to J) becomes incident upon a corresponding one of said photodetectors (52M to 52J).

2. An optical pickup apparatus according to claim 1,

wherein the plurality of light beams are generated by making light from a light source (14) pass through a diffraction grating (20).

3. An optical pickup apparatus according to claim 1, wherein at least one of said plurality of photodetectors (52M to 52J) includes a plurality of light reception areas for divisionally receiving one light beam.

4. An optical pickup apparatus according to claim 1, wherein an optical axis (32) of the reflected light passing through the collimator is changed to an optical axis (66) toward said focus adjusting means (50) by a beam splitter (24) upon which the reflected light passed through the collimator becomes incident.

5. An optical pickup apparatus according to claim 4, wherein the reflected light incident upon each photodetector is visually confirmed by detecting means (CCD).

6. An optical pickup apparatus according to claim 5, wherein said detecting means is disposed on an opposite side of the beam splitter (24) relative to said focus adjusting means (50).

7. An optical pickup apparatus according to claim 1, wherein said focus adjusting means is made movable between the beam splitter and said photodetectors.

8. An optical pickup apparatus according to claim 7, wherein said focus adjusting means is moved by being slid on said chassis.

9. An optical pickup apparatus according to claim 7, wherein a distance (y) between a plane (68) on which said photodetectors are disposed and said focus adjusting means and a distance (x) between the plane and the beam splitter are maintained to have a predetermined relation (y = ax + b where a and b are constants), and said focus adjusting means is made movable between the beam splitter and said photodetectors.

10. A method of manufacturing an optical pickup apparatus having objective spot forming means (30) for forming each spot (M, E, F, G, H, I, and J) of a plurality of light beams entered via a collimator (28), on each track of a recording medium (34), a plurality of photodetectors (52M, 52E, 52E, 52F, 52G, 52H, 52I, and 52J) each provided for each spot (M to J) for receiving reflected light of each

spot (M to J), the reflected light having passed through said objective spot forming means (30), said collimator (28), and focus adjusting means (50) in this order, and a chassis (70) mounted with said collimator (28), the method comprising the steps of:

changing a first distance along an optical axis direction between the collimator (28) and said focus adjusting means (50) and a second distance along the optical axis direction between the collimator (28) and said photodetectors (52M to 52J);

searching the first and second distances along the optical axis direction which allow the reflected light of each of said spots (M to J) become incident upon a corresponding one of said photodetectors (52M to 52J); and

fixing said focus adjusting means (50) and said photodetectors (52M to 52J) to said chassis (7) at the searched first and second distances along the optical axis direction.

11. A method of manufacturing an optical pickup apparatus according to claim 10, wherein changing the first and second distances along the optical axis direction is performed while a predetermined relation between the first and second distances is maintained.

12. A method of manufacturing an optical pickup apparatus according to claim 10, wherein an optical axis (32) of the reflected light passing through the collimator is changed to an optical axis (66) toward said focus adjusting means (50) by a beam splitter (24) upon which the reflected light passed through the collimator becomes incident.

13. A method of manufacturing an optical pickup apparatus according to claim 10, wherein detecting means (CCD) is provided on a side opposite to the beam splitter relative to said focus adjusting means, and the first and second distances are searched by said detecting means while said focus adjusting means is moved between the beam splitter and said photodetectors.

14. A method of manufacturing an optical pickup apparatus according to claim 13, wherein a distance (y) between a plane (68) on which said photodetectors are disposed and said focus adjusting means and a distance (x) between the plane and the beam splitter are maintained to have a predetermined relation ($y = ax + b$ where a and b are constants), and said focus adjusting means is made movable between the beam splitter and said photodetectors.

15. A method of manufacturing an optical pickup apparatus

having objective spot forming means (30) for forming each spot (M, E, F, G, H, I, and J) of a plurality of light beams entered via a collimator (28), on each track of a recording medium (34), a plurality of photodetectors (52M, 52E, 52E, 52F, 52G, 52H, 52I, and 52J) each provided for each spot (M to J) for receiving reflected light of each spot (M to J), the reflected light having passed through said objective spot forming means (30), said collimator (28), and focus adjusting means (50) in this order, and a chassis (70) mounted with said collimator (28), the method comprising the step of:

adjusting a focal length for said photodetectors by changing a first distance along an optical axis direction between the collimator (28) and said focus adjusting means (50) and a second distance along the optical axis direction between the collimator (28) and said photodetectors (52M to 52J).

16. An optical pickup apparatus comprising:

(a) objective spot forming means (30) for forming each spot (M, E, F, G, H, I, and J) of a plurality of light beams entered via a collimator (28), on each track of a recording medium (34);

(b) a plurality of photodetectors (52M, 52E, 52E, 52F, 52G, 52H, 52I, and 52J) each provided for each spot (M to

J) for receiving reflected light of each spot (M to J), the reflected light having passed through said objective spot forming means (30), said collimator (28), and focus adjusting means (50) in this order;

(c) a chassis (70) mounted with said collimator (28); and

(d) means (72, 78) for adjusting a distance between said focus adjusting means and said photodetectors,

wherein said adjusting means includes a first member (72) for supporting said focus adjusting means and a second member (78) supported by said chassis in a slidable manner for supporting said photodetectors, and the distance is adjusted by moving the first member along said chassis.

17. A method of adjusting a distance between focus adjusting means and photodetectors for an optical pickup apparatus having objective spot forming means (30) for forming each spot (M, E, F, G, H, I, and J) of a plurality of light beams entered via a collimator (28), on each track of a recording medium (34), a plurality of photodetectors (52M, 52E, 52E, 52F, 52G, 52H, 52I, and 52J) each provided for each spot (M to J) for receiving reflected light of each spot (M to J), the reflected light having passed through said objective spot forming means (30), said collimator (28), and said focus adjusting means (50) in

this order; and a chassis (70) mounted with said collimator (28), the method comprising the steps of:

providing image pickup means (CCD) on an axial line (66) between said photodetectors and said focus adjusting means, said image pickup means picking up the reflected light;

displaying the reflected light picked up by said image pickup means on a display (50a); and

moving said focus adjusting means along the axial line by monitoring the display to search a position along the axial line which allows the reflected light to become incident upon said photodetectors.

18. An optical pickup apparatus comprising:

(a) a light reflection optical element (118, 1120, 11122, 1124, 1126) for reflecting a plurality of light beams incoming along a direction of a first axial line (120), toward a direction of a second axial line (122) different from the first axial line;

(b) spot forming means (126) for forming a spot (M, E, F, G, H, I, and J) of each light beam incoming along the direction of the second axial line (122) from said light reflection optical element (118, 1120, 1122, 1124, 1126), on each track (142) of a recording medium (128);

(c) support means (170, 182) for rotatably supporting

said light reflection optical element (118, 1120, 1122, 1124, 1126) about at least one rotation axial line on a chassis (180), the rotation axial line passing a reference point (138) which is a cross point between the first and second axial lines (120, 122);

(d) fixing means (198, 1102) for fixing said light reflection optical element (118, 1120, 1122, 1124, 1126) to the chassis (180); and

(e) reflected light detecting means (134) for detecting reflected light of each spot (M to J) passed through said spot forming means (126).

19. An optical pickup apparatus according to claim 18, wherein the rotation axial line includes a rotation axial line perpendicular to both the first axial line (120) and the second axial line (122).

20. An optical pickup apparatus according to claim 18, wherein the rotation axial line includes a rotation axial line coincident with the first axial line (120).

21. An optical pickup apparatus according to claim 18, wherein the rotation axial line includes a rotation axial line coincident with the second axial line (122).

22. An optical pickup apparatus according to claim 18, wherein said support means (170, 192) includes a spherical fitting portion (170, 192).

23. An optical pickup apparatus according to claim 18, wherein said light reflection optical element is a triangular prism (118).

24. An optical pickup apparatus according to claim 23, wherein said light reflection optical element is an inner surface reflection type triangular prism (1120), and the light beam is reflected by a reflection surface (140).

25. An optical pickup apparatus according to claim 18, wherein said light reflection optical element is a semispheric mirror (1122).

26. An optical pickup apparatus according to claim 18, wherein said light reflection optical element is a circular disc mirror (1124).

27. An optical pickup apparatus according to claim 18, wherein said support means includes a concave spherical portion (170) and a convex spherical portion (192) which can be spherically fitted together.

28. An optical pickup apparatus according to claim 27, wherein said light reflection optical element is held by holding means (160) partially constituting said support means, said fixing means is a screw (198), said holding means is fixed to the chassis by the screw via a washer, and a height of the washer is changed with a threading amount of the screw to thereby tightly fit together the concave spherical portion and the convex spherical portion.

29. An optical pickup apparatus according to claim 18, wherein said light reflection optical element is held by holding means (160) partially constituting said support means, said fixing means is a screw (198), said holding means is fixed to the chassis by the screw, a screw hole of the chassis has a diameter larger than a diameter of a shaft of the screw, and said light reflection optical element can be displaced along the chassis by an amount corresponding to a difference between the diameters.

30. An optical pickup apparatus comprising:

(a) a light reflection optical element (118, 1120, 11122, 1124, 1126) for reflecting a plurality of light beams incoming along a direction of a first axial line (120), toward a direction of a second axial line (122) different from the first axial line;

(b) spot forming means (126) for forming a spot (M, E, F, G, H, I, and J) of each light beam incoming along the direction of the second axial line (122) from said light reflection optical element (118, 1120, 1122, 1124, 1126), on each track (142) of a recording medium (128);

(c) support means (1110) for movably supporting said light reflection optical element (118, 1120, 1122, 1124, 1126) on the chassis along the direction of the first axial lie (120) and/or the direction of the second axial line (122);

(d) fixing means (198, 1102) for fixing said light reflection optical element (118, 1120, 1122, 1124, 1126) to the chassis (180); and

(e) reflected light detecting means (134) for detecting reflected light of each spot (M to J) passed through said spot forming means (126).

31. An optical pickup apparatus according to claim 27, wherein said light reflection optical element is held via a mount member (172) by holding means (160a) partially constituting said support means, said mount member is fixed to said holding means by a screw (1114) via a washer (1112), a height of the washer is changed with a threading amount of the screw to thereby moving up and down said light reflection optical element.

32. An optical pickup apparatus according to claim 31, wherein said support means (110) regulate said mount member from being rotated during threading the screw, in a direction of threading the screw.

33. A method of adjusting a rotary position of a light reflection optical element for an optical pickup apparatus having the light reflection optical element (118, 1120, 11122, 1124, 1126) for reflecting a plurality of light beams incoming along a direction of a first axial line (120), toward a direction of a second axial line (122) different from the first axial line, spot forming means (126) for forming a spot (M, E, F, G, H, I, and J) of each light beam incoming along the direction of the second axial line (122) from said light reflection optical element (118, 1120, 1122, 1124, 1126), on each track (142) of a recording medium (128), support means (170, 182) for rotatably supporting said light reflection optical element (118, 1120, 1122, 1124, 1126) about at least one rotation axial line on a chassis (180), the rotation axial line passing a reference point (138) which is a cross point between the first and second axial lines (120, 122), fixing means (198, 1102) for fixing said light reflection optical element (118, 1120, 1122, 1124, 1126) to the chassis (180), and reflected light detecting means (134) for detecting

reflected light of each spot (M to J) passed through said spot forming means (126), the method comprising the steps of:

providing image pickup unit (CCD) in place of the recording medium;

displaying the spots picked up by said image pickup means on a display; and

adjusting the rotary position of said light reflection optical element by rotating said light reflection optical element about the at least one rotation axial line while the display is monitored, so as to allow the spots (M to J) on the recording medium (128) to enter an effective area of said spot forming means (126) and/or so as to make the focus states of the spots (M to J) be generally the same.

34. An optical pickup apparatus having a photodiode unit (224) mounted on a holder (216) having a bonding surface (240) bonded to a holder mount surface (214) of a base (212) and a position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108) for receiving a position adjusting pin (256), the holder (216) being bonded to the base (212) after the holder (216) is aligned with a proper position by the position adjusting pin (256), wherein:

said holder (216) has a shielding portion (278, 286) for shielding said holder mount surface (214) from said position adjusting pin receptacle (222, 284, 296, 298,

2104, 2106, 2108).

35. An optical pickup apparatus according to claim 34, wherein said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108) is a recess (222, 284, 296, 298) which is open on a side opposite to the holder mount surface (214) and close on a side of the holder mount surface (214), and a close end of said recess (222, 284, 286, 298) constitutes said shielding portion (278, 286).

36. An optical pickup apparatus according to claim 34, wherein said holder (216) is provided with a projection (276, 294) projecting to a side opposite to the holder mount surface (214), and a recess (222, 296, 298) being open at a top surface of said projection (276, 294) is formed in said projection (276, 294).

37. An optical pickup apparatus according to claim 34, wherein a projection (2104, 2106, 2108) projects from a surface (242) on a side opposite to the bonding surface (240) toward a side opposite to the holder mount surface (214), and a top circumference area of said position adjusting receptacle (256) is inserted into an engaging hole of said position adjusting pin (256).

38. An optical pickup apparatus according to claim 34, wherein a guide groove (288) is formed on the bonding surface (240) of said holder (216), said guide groove (288) guiding preliminary adhesive (270) from a preliminary mount adhesive dropping area (266) to a direction different from a direction toward said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108).

39. A holder comprising:

a plurality of position adjusting pin receptacles (222, 284, 296, 298, 2104, 2106, 2108) for receiving a plurality of position adjusting pins (296);

a bonding surface (240) bonded to a holder mount surface (214) of a base (212);

a mount (218) for mounting a photodetector unit (224); and

a shielding portion (278, 286) for shielding said holder mount surface (214) from each of said position adjusting pin receptacles (222, 284, 296, 298, 2104, 2106, 2108).

40. A holder comprising:

a plurality of position adjusting pin receptacles (222, 284, 296, 298, 2104, 2106, 2108) for receiving a plurality of position adjusting pins (296);

a bonding surface (240) bonded to a holder mount surface (214) of a base (212);

a mount (218) for mounting a photodetector unit (224); and

a plurality of guide grooves (288) for guiding preliminary adhesive (270) from a preliminary mount adhesive dropping area (266) to a direction different from a direction toward said position adjusting pin receptacles (222, 284, 296, 298, 2104, 2106, 2108).

41. A method of manufacturing an optical pickup apparatus having a photodiode unit (224) mounted on a holder (216) having a position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108) and a shielding portion (278, 286) for shielding a holder mount surface (214) of a base (212) from said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108), the method comprising the steps of:

(a) aligning said holder (216) with a proper position by using a position adjusting pin (256) fitted in said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108);

(b) dropping preliminary mount adhesive (270) down to a preliminary mount adhesive dropping area (266) between the holder mount surface (214) of the base (212) and a bonding surface (240) of said holder (216) to preliminarily

mount said holder (216) on said base (212); and

(c) removing said position adjusting pin (256) from said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108).

42. A method of manufacturing an optical pickup apparatus having a photodiode unit (224) mounted on a holder (216) having a position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108) and a guide groove (288) for guiding preliminary adhesive (270) from a preliminary mount adhesive dropping area (266) to a direction different from a direction toward said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108), the method comprising the steps of:

(a) aligning said holder (216) with a proper position by using a position adjusting pin (256) fitted in said position adjusting pin receptacle (222, 284, 296, 298, 2104, 2106, 2108);

(b) dropping preliminary mount adhesive (270) down to the preliminary mount adhesive dropping area (266) between the holder mount surface (214) of the base (212) and a bonding surface (240) of said holder (216) to preliminarily mount said holder (216) on said base (212); and

(c) removing said position adjusting pin (256) from said position adjusting pin receptacle (222, 284, 296, 298,

2104, 2106, 2108).

43. An optical pickup apparatus according to claim 34, wherein a shape of said receptacle is cylindrical, cubic, or conical.

44. An optical pickup apparatus according to claim 35 or 36, wherein said recess (296) is an opening having a rectangular cross sectional shape.

45. An optical pickup apparatus according to claim 35 or 36, wherein said recess (298) is an opening having a triangular cross sectional shape.

46. An optical pickup apparatus according to claim 38, wherein said guide groove has a V-character cross sectional shape.

47. A holder according to claim 39, wherein a shape of said receptacle is cylindrical, cubic, or conical.

48. A holder according to claim 39, wherein said shielding portion (286) is a recess (284) formed on a non-bonding surface (242) of said holder.

49. A holder according to claim 40, wherein said guide groove has a V-character cross sectional shape.

50. A method according to claim 41, wherein a shape of said receptacle is cylindrical, cubic, or conical.

51. A method according to claim 42, wherein a shape of said receptacle is cylindrical, cubic, or conical.

52. A method according to claim 42, wherein said guide groove has a V-character cross sectional shape.